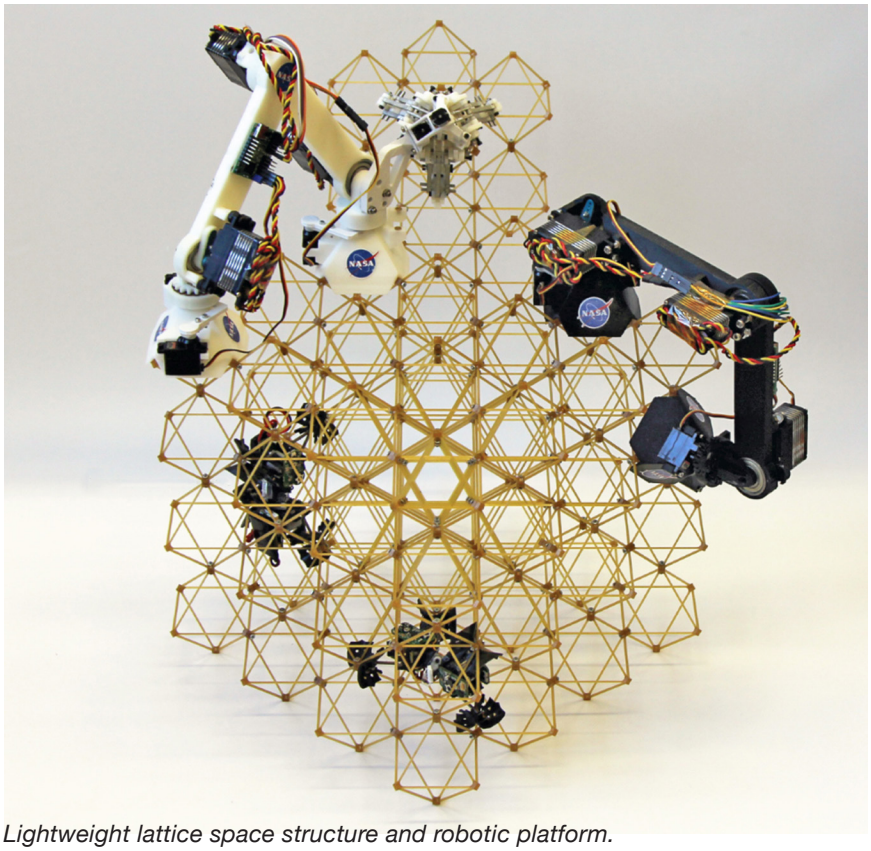
NASAfacts

Space Technology
Game Changing Development
Automated Reconfigurable Mission Adaptive Digital Assembly Systems (ARMADAS)

The Automated Reconfigurable Mission Adaptive Digital Assembly Systems (ARMADAS) project will develop and demonstrate autonomous assembly of building block-based “digital materials” and structures. This will present automation technologies with potential for meeting long duration and deep space infrastructure needs, including achieving in-space reliance with construction and maintenance of long duration spaceport and habitat scale systems.

The full demonstration system is composed of robots and physical building blocks that are autonomously unpacked and configured to multiple structures such as a habitat and an antenna array. The long-term goal is to enable a future spacecraft technology demonstration flight, leading to autonomous assembly of on-orbit space port structures, moon or Mars surface habitat structures, and large aperture instrumentation.

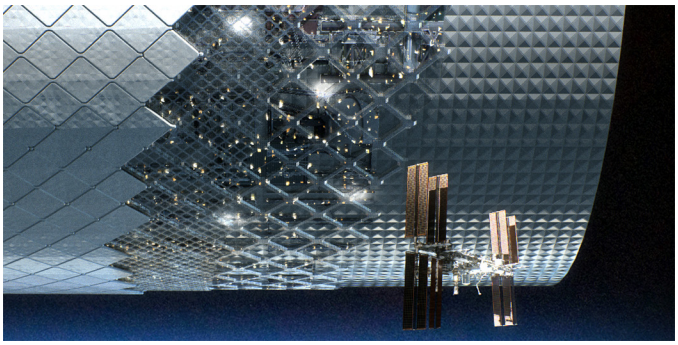


Lightweight lattice space structure and robotic platform.
Credit: MIT Center for Bits and Atoms.

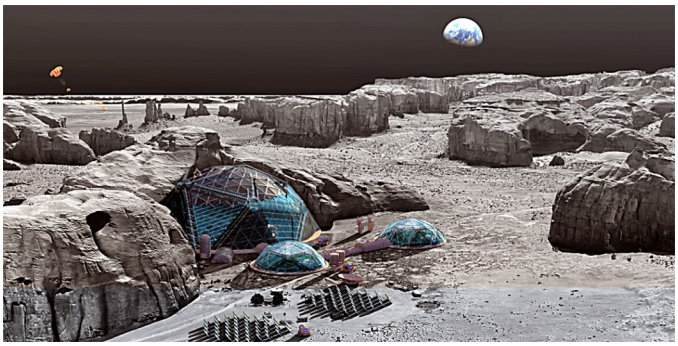
The energy required to manufacture hardware with conventional material processing methods is equal to or greater than the specific energy cost of launching material to low-Earth orbit. Assembly and reconfiguration of materials and structures from discrete building blocks is being studied for the potential to bypass the performance and/or size limitations (i.e., launch payload space) of typical production methods. This extends the versatility of conventional additive manufacturing strategies to best practice high performance constituent materials and with scalability to large assemblies at state-of-the-art manufacturing precision.

Modular and reconfigurable construction have been appreciated throughout technological history—a key philosophical idea behind building block-based systems is that these systems can be engineered to be highly scalable. Global precision is achieved by careful design of connections that display symmetric error distributions, allowing for tolerances that do not increase with system size. These strategies have recently yielded record breaking (specific strength and stiffness) materials and structural systems, as are relevant to space systems.

If successful, building block-based materials and manufacturing reduces the primary in-space resource utilization problem to the production and handling of a small library of building block components. Complex assemblies that utilize large amounts of those components can still achieve a vast range of material properties and functional mechanisms (such as would be needed for "space-reliance") through the geometric or topological arrangement of the different building block types. This is similar to the ability of a digital image to approximate any image, given high enough resolution,



ARMADAS space port conceptualization.



Lightweight ARMADAS lunar habitat conceptualization.

with a very simple set of discrete components. We know that this works for mechanical/structural systems, with discrete three dimensional building blocks (digital cellular composites). The most significant technology gap is in the area of assembly mechanisms, which is the focus of the ARMADAS project.

The Game Changing Development (GCD) program is part of NASA's Space Technology Mission Directorate. The GCD program aims to advance exploratory concepts and deliver technology solutions that enable new capabilities or radically alter current approaches.

For more information about GCD, please visit http://gameon.nasa.gov/

National Aeronautics and Space Administration

Ames Research Center
Silicon Valley, CA 94035

www.nasa.gov